

## (1mark Questions)

### Q.1- What is slag?

A.1- It is easily fusible material, which is formed when gangue still present in roasted ore combines with the flux.

e.g.  $\text{CaO (flux)} + \text{SiO}_2 \text{ (gangue)} \rightarrow \text{CaSiO}_3 \text{ (slag)}$

### Q.2- Which is better reducing agent at 983K, carbon or CO?

A.2- CO, (above 983K CO being more stable & does not act as a good reducing agent but carbon does.)

### Q.3- At which temperature carbon can be used as a reducing agent for FeO?

A.3- Above 1123K, carbon can reduce FeO to Fe.

### Q.4- What is the role of graphite rods in electrometallurgy of aluminium?

A.4- Graphite rods act as anode, are attacked by oxygen to form  $\text{CO}_2$  and so to be replaced over time.

### Q.5- What is the role of cryolite in electrometallurgy of aluminium?

A.5- alumina cannot be fused easily because of high melting point. Dissolving of alumina in cryolite furnishes  $\text{Al}^{3+}$  ions, which can be electrolyzed easily.

### Q.6- What are depressants?

A.6- It is possible to separate two sulphide ore by adjusting proportion of oil to water in froth flotation process by using a substance known as depressant.

e.g. NaCN is used to separate ZnS and PbS.

### Q.7- Copper can be extracted by hydrometallurgy but not Zn. Why?

A.7- The  $E_0$  of Zn is lower than that of Cu thus Zn can displace  $\text{Cu}^{2+}$  ion from its solution. On other hand side to displace Zn from  $\text{Zn}^{2+}$  ion, we need a more reactive metal than it.

### Q.8- Give name and formula of important ore of iron .

A.8- Haematite –  $\text{Fe}_2\text{O}_3$ , Magnetite –  $\text{Fe}_3\text{O}_4$ , Iron pyrites  $\text{FeS}_2$ .

### Q.9- Give name and formula of important ore of Copper .

A.9- Copper pyrites  $\text{CuFeS}_2$ , Malachite  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ , Cuprite  $\text{Cu}_2\text{O}$ .

### Q.10- Give name and formula of important ore of Zinc .

A.10- Zinc blende -  $\text{ZnS}$ , Calamine-  $\text{ZnCO}_3$ , Zincite –  $\text{ZnO}$  .

## SHORT ANSWER TYPE QUESTION

(2 marks)

### Q.1 Describe the method of refining of nickel.

A.1- In the Mond Process, Ni is heated in a stream of CO forming a volatile complex, which then decomposes at higher temperature to give Ni.

At 330-350K:  $\text{Ni} + 4\text{CO} \rightarrow \text{Ni}(\text{CO})_4$

At 450-470K  $\text{Ni}(\text{CO})_4 \rightarrow \text{Ni} + 4\text{CO}$

### Q.2- What is Zone Refining? Explain with example.

A.2- Zone refining is a method of obtaining a metal in very pure state. It is based on the principle that impurities are more soluble in molten state of metal than solidified state.

In this method, a rod of impure metal is moved slowly over circular heater. The portion of the metal being heated melts & forms the molten zone. As this portion of the rod moves out of heater, it solidifies while the impurities pass into molten zone. The process is repeated to obtain ultrapure metal and end of rod containing impure metal cutoff.

### Q.3 Write the principle of electro-refining.

A.3- In this method of purification impure metal is made Anode and pure metal is made the cathode. On passing electricity, pure metal is deposited at the cathode while the impurities dissolve in solution as anode mud. E.g. electro- refining of copper:-

At Cathode: -  $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

At Anode: -  $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ .

**Q.4- Describe the method of refining of Zirconium and Titanium.**

A.4- Van Arkel process is used for obtaining ultrapure metal. The impure metal is converted into volatile compound, which then decomposes electrically to get pure metal.

At 850K: -  $\text{Zr (impure)} + 2 \text{I}_2 \rightarrow \text{ZrI}_4$

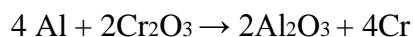
At 2075K:-  $\text{ZrI}_4 \rightarrow \text{Zr (pure)} + 2 \text{I}_2$

**Q.5- Out of C & CO, which is better reducing agent for ZnO?**

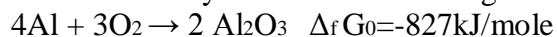
A.5- Since free energy of formation of CO from C is lower at temperature above 1120K while that of CO<sub>2</sub> from carbon is lower above 1323K than free energy of formation of ZnO. However, the free energy of formation of CO<sub>2</sub> from CO is always higher than that of ZnO. Hence, C is better reducing agent of ZnO.

**Q.7- The value of  $\Delta_f G_0$  for Cr<sub>2</sub>O<sub>3</sub> is -540kJ/mole & that of Al<sub>2</sub>O<sub>3</sub> is -827kJ/mole. Is the reduction of Cr<sub>2</sub>O<sub>3</sub> possible with aluminium?**

A.7- The desired conversion is



It is obtained by addition of following two reactions:-



Therefore,  $\Delta G_0$  for desired reaction is  $-827+540=-287$ , as a result reduction is possible.

**Q.8:- Why copper matte is put in silica lined converter?**

A.8:- Copper matte consists of Cu<sub>2</sub>S and FeS. When blast of air is passed through molten matte in silica-lined converter, FeS present in matte is oxidized to FeO, which combines with silica to form slag.

(i)  $2\text{FeS} + 3\text{O}_2 \rightarrow 2\text{FeO} + 2 \text{SO}_2$ , (ii)  $\text{FeO} + \text{SiO}_2 \rightarrow \text{FeSiO}_3$  (slag),

(III)  $2\text{Cu}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$ , (IV)  $2\text{Cu}_2\text{O} + 2\text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$

**Q.9- What is meant by term chromatography?**

A.9-Chromato means Colour and graphy means writing because the method was first used for separation of coloured substance. It is based on selective distribution of various constituents of a mixture between two phases, a stationary phase and a moving phase. The stationary phase can be either solid or liquid on solid support.

**Q.10-Why is reduction of metal oxide easier if metal formed is in liquid state at temperature of reduction.**

A.10- The entropy of a substance is higher in liquid state than solid state. In the reduction of metal oxide, the entropy change will be positive if metal formed is in liquid state. Thus, the value of  $\Delta G_0$  becomes negative and reduction occurs easily.

#### SHORT ANSWER TYPE QUESTION(3 marks)

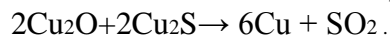
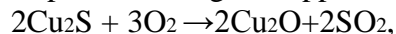
**Q.1- Explain the following:-**

(i) Zinc but not copper is used for recovery of Ag from the complex  $[\text{Ag}(\text{CN})_2]$ .

(ii) Partial roasting of sulphide ore is done in the metallurgy of copper.

(iii) Extraction of Cu from pyrites is difficult than that from its oxide ore through reduction.

A.1- (i) Zn is more powerful reducing agent in comparison to copper. Zn is also cheaper than Cu.  
(ii) Partial roasting of sulphide ore forms some oxide. This oxide then reacts with remaining sulphide ore to give copper i.e. self-reduction occurs.



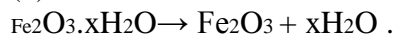
(iii) Though carbon is good reducing agent for oxide but it is poor reducing agent for sulphides. The reduction of metal sulphide does not have large negative value.

**Q.2- Explain the method for obtaining pig iron from magnetite.**

A.2- Extraction of iron from Magnetite takes place in following steps:-

(i) Concentration of ore: - It is done by Gravity separation followed by magnetic separation process.

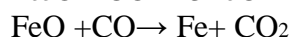
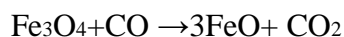
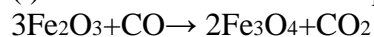
(ii) Calcination: - It involve heating when the volatile matter escapes leaving behind metal oxide.



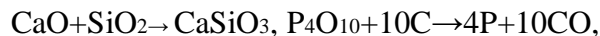
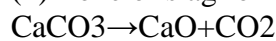
(iii) Roasting: - It involves heating of ore in presence of air, thus moisture,  $\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{As}_2\text{O}_3$  removed And FeO oxidized to  $\text{Fe}_2\text{O}_3$ .

(iv) Smelting of roasted ore: - A mixture of ore, coke &  $\text{CaCO}_3$  is smelted in long BLAST FURNACE. Following reaction takes place at different temperature zones:-

(i) Zone of reduction: - Temperature range  $250^\circ\text{C}$ - $700^\circ\text{C}$



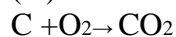
(ii) Zone of slag formation:- Temperature range  $800^\circ\text{C}$ - $1000^\circ\text{C}$



(iii) Zone of fusion:- Temperature range  $1150^\circ\text{C}$ - $1350^\circ\text{C}$



(iv) Zone of fusion:- Temperature range  $1450^\circ\text{C}$ - $1950^\circ\text{C}$



Thus, Pig iron is obtained from Blast Furnace.

Q.3- Describe the principles of extraction of copper from its ore .

**Q.4- Name the principal ore of aluminium and describe how Al is extracted from its ore.**

A.4- Important ores -(i) Bauxite  $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$  (ii) Corundum  $\text{Al}_2\text{O}_3$ . Bauxite is commercially important ore of Al.

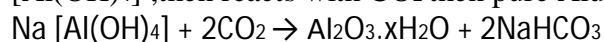
Extraction from Bauxite ore involves the following two stages:-

(i) Purification of bauxite to get pure alumina ( $\text{Al}_2\text{O}_3$ )

(ii) Electrolysis of pure alumina in molten cryolite

Step:-1 Bauxite is treated with NaOH .Following reaction takes place:-

$\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2 \text{Na} [\text{Al}(\text{OH})_4]$  and impurities of  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$  &  $\text{SiO}_2$  are removed . Na  $[\text{Al}(\text{OH})_4]$  ,then reacts with  $\text{CO}_2$  then pure Alumina is obtained.



Step:-2 Electrolytic reduction of pure alumina takes place in iron box (cathode) with cryolite ( $\text{Na}_3\text{AlF}_6$ ) & fluorspar  $\text{CaF}_2$ . Graphide rods act as anode. Following reactions take place:-

At cathode:-  $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$ , At Anode:-  $2\text{O}_2^- \rightarrow \text{O}_2 + 4\text{e}^-$ .

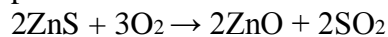
By this process 98.8% pure Aluminum is obtained.

**Q.5- Describe the principles of extraction of Zinc from zinc blende .**

A.5- Important ores of Zn:-Zinc blende - ZnS, Calamine- ZnCO<sub>3</sub>, and Zincite – ZnO. ZnS is commercially important ore of Zn. Various stages involved in the extraction of Zn from ZnS are as following:-

(i) Concentration of ore:-It is concentrated by Froth flotation process followed by gravity separation process.

(ii) Roasting: - The concentrated ore is roasted in presence of air. Following reactions take place:-



The mass obtained during roasting is porous and is called porous clinker.

(iii) Reduction of ZnO to Zn: - ZnO is made into bricketts with coke and clay and heated at 163K. Zn formed distills off and is collected by rapid cooling of zinc vapours.

